Global Astrophysical Telescope System – test results from telescope nr 2

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We present first results of observational examination of our new 0.7m spectroscopic telescope before and after its transportation to Winer Observatory in Arizona, USA. Spectrograph stability tests show that we should be able to achieve a precision of 20 m/s. Photometric tests using our diffraction technique, dedicated for very bright stars, prove that a precision of at least 0.005 mag is achievable.

1 Introduction

The Global Astrophysical Telescope System (GATS) is a project intended to operate a pair of astronomical spectroscopic telescopes located at two different geographic longitudes and similar northern latitudes. The first telescope (PST1), installed in Borowiec near Poznań (Poland) is operational since 2007 (Baranowski et al., 2009). The second telescope (PST2) is currently being tested at Winer Observatory in Arizona and will be operated in fully robotic mode. Together they will constitute a network, which, thanks to a time difference, will be able to perform nearly continuous (up to 21 h/day) optical spectroscopy.

2 The new telescope

Poznań Spectroscopic Telescope 2 (PST2) - the younger brother of the pair - is a slightly improved version of our first instrument. We built it using a different telescope, but with a very similar spectrograph design. The telescope is a new model from Planewave - CDK700, with diameter of 0.7 m and f/6.6 focal ratio and an alt-az robotic direct-drive mount. The spectrograph is an echelle type with resolution of $R \sim 40000$ and 385-900 nm wavelength range. It uses a fiber feeding and provides a simultaneous input light flux variations measurement. We are considering the use of iodine cell as well - the telescope has been prepared for that option. The main spectroscopic camera is an Andor iKon-L 939. It enables us to record spectra with S/N$\sim$5 for 11 mag stars exposed for 1800 s. This is perfectly useful for radial velocity measurements of late spectral types. The telescope is equipped with a 10 cm guider scope for simultaneous photometry. Everything is controlled remotely with our dedicated software and fully autonomous operation mode is also being tested.

3 Spectroscopy

The echelle spectrograph of PST2 is designed to maintain substantial thermal stability for periods of time of up to a few months. Any residual changes of temperature,

Fig. 1: The PST2 telescope at the target site - left panel. The PST2 echelle spectrograph inside its thermostatic box -right panel.

as well as changes in atmospheric pressure, are recorded with a precision of of 0.01 °C and 0.01 hPa. This should allow post-observation refinement of spectrograph radial velocity shifts. Our preliminary tests show that it should be possible to correct radial velocities to ~ 20 m/s RMS using a single-point temperature and pressure measurement inside the spectrograph box.

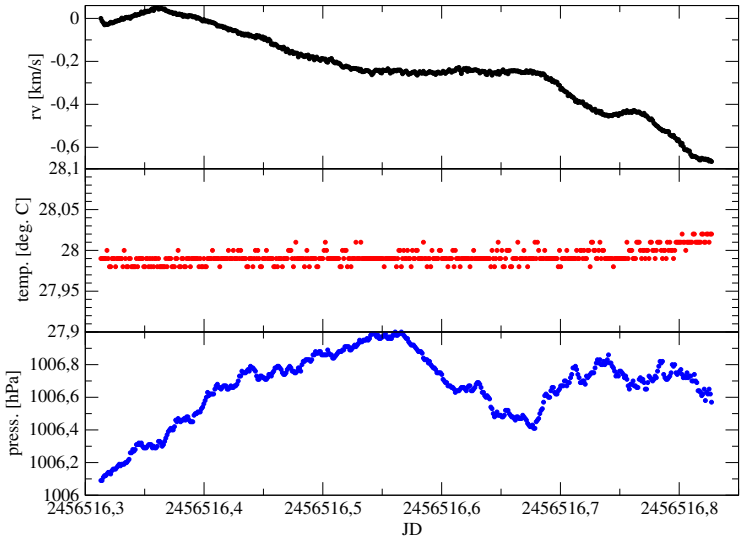

Fig. 2: The PST2 spectrograph stability test. Top: radial velocity variations of Th-Ar reference lamp spectrum; middle: temperature inside the spectrograph stabilised at one point; bottom: pressure variations.

4 Photometry

The 10 cm auxiliary guider scope is capable of making simultaneous photometric observations of even very bright spectroscopic targets. It is possible thanks to use of a wire mesh and overexposing central diffraction fringes of target stars. A relative photometry of secondary images of target and primary images of reference stars allow to overcome the problem of incommensurable light flux levels. We tested both wire mesh configurations: objective mesh with 1.5 mm pitch and filter wheel mesh with 0.1 mm pitch, and selected the objective version because of field rotation. The precision of 0.005 mag seems easily achievable for Δmag$\sim$5 (Kamiński et al., 2014).

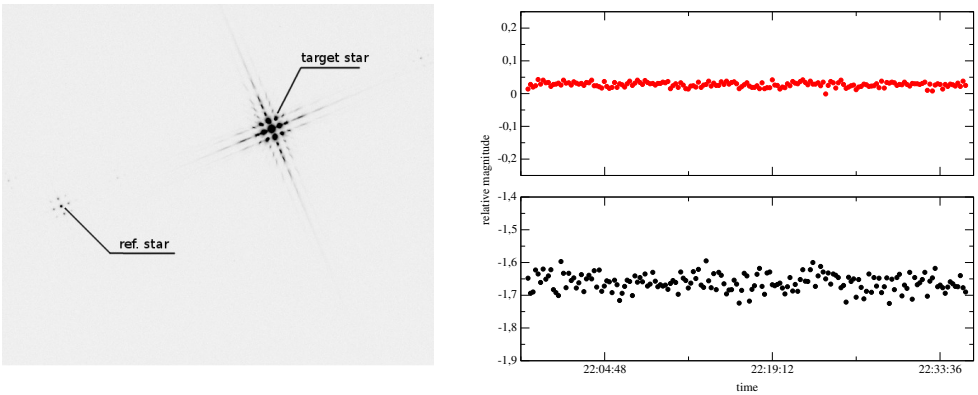

Fig. 3: CCD frame of η Boo taken with PST2 guider scope with a wire mesh installed on filter - left panel. Target star secondary image and reference star primary image selected for photometry are marked. On the right panel we present: top - the relative brightness changes of two selected secondary images of the target star; bottom - light curve of a target star with respect to reference star. Despite the brightness difference of 4.5 mag we obtained a precision of 0.025 mag, further tests have shown even better results, as reported in (Kamiński et al., 2014).

References

Baranowski, R., et al., *V440 Per: the longest-period overtone Cepheid*, MNRAS **396**, 2194 (2009)

Kamiński, K., Schwarzenberg-Czerny, A., Zgórz, M., *CCD Photometry of Bright Stars Using Objective Wire Mesh*, AJ **147**, 158 (2014)